

1 TITLE OF THE INVENTION

2 VEHICLE DRIVE ASSIST SYSTEM

3

4 BACKGROUND OF THE INVENTION

5 1. Field of the invention

6 The present invention relates to a vehicle drive assist
7 system for making a follow-up control targeting a preceding vehicle
8 which travels in front of an own vehicle, taking a vehicle traveling
9 in front of the preceding vehicle into consideration based on
10 frontal information detected by a stereoscopic camera, a
11 millimeter wave radar and the like.

12 2. Discussion of related arts

13 In recent years, a vehicle traveling control system
14 in which a preceding vehicle existing ahead of an own vehicle
15 or a vehicle ahead of the preceding vehicle are detected from
16 traveling circumstances detected by a stereoscopic camera, a
17 millimeter wave radar and the like and a follow-up traveling control
18 targeting the preceding vehicle is performed, has been put into
19 practical use.

20 For example, Japanese Patent Application Laid-open No.
21 Toku-Kai-Hei 11-108661 discloses a technique in which, when a
22 relatively small vehicle or a motor cycle cuts in ahead of the
23 own vehicle, these vehicles can be recognized and accurately
24 followed up by monitoring circumstances in front of the own vehicle
25 taken with an imaging apparatus using a monitoring window or a

1 follow-up window.

2 However, in case of such a technology as described above,
3 for example, there is a problem that, when the motor cycle
4 established as a follow-up object is undertaking to pass the
5 vehicle in front of the motor cycle, also the own vehicle accelerates
6 in order to catch up with the motorcycle. As a result, the own
7 vehicle comes too close to the vehicle traveling in front of the
8 preceding vehicle.

9

10 SUMMARY OF THE INVENTION

11 It is an object of the present invention to provide
12 a vehicle drive assist system capable of making an optimal follow-up
13 control according to traveling conditions in case where a preceding
14 vehicle undertakes to pass a vehicle traveling ahead of the
15 preceding vehicle.

16 In order to attain that object, a drive assist system
17 having solid object detecting means for detecting frontal solid
18 objects including a preceding vehicle traveling ahead of an own
19 vehicle and a second preceding vehicle traveling ahead of the
20 preceding vehicle and traveling control means including
21 follow-up traveling control means for establishing the preceding
22 vehicle as a follow-up object and for controlling a traveling
23 of the own vehicle so as to follow up the preceding vehicle,
24 comprises means for inhibiting an acceleration of the own vehicle
25 following up the preceding vehicle when a first state where the

1 preceding vehicle undertakes to pass the second preceding vehicle
2 is detected, means for continuing to establish the preceding
3 vehicle as a follow-up object until a second state where the
4 preceding vehicle travels in parallel with the second preceding
5 vehicle is detected, means for changing the follow-up object from
6 the preceding vehicle to the second preceding vehicle when the
7 second state changes to a third state where the speed of the
8 preceding vehicle is larger than that of the second preceding
9 vehicle, and means for continuing to establish the preceding
10 vehicle as the follow-up object when the second state changes
11 to a fourth state where the speed of said preceding vehicle is
12 smaller than that of the second preceding vehicle.

13 Further, in a state where the preceding vehicle and
14 the second preceding vehicle run in parallel, the preceding
15 vehicle can be accurately discriminated from the second preceding
16 vehicle based on the memorized widths of these vehicle and the
17 direction of the movement of the preceding vehicle.

18

19 BRIEF DESCRIPTION OF THE DRAWINGS

20 Fig. 1 is a schematic view showing a vehicle
21 incorporating a vehicle drive assist system according to a first
22 embodiment of the present invention;

23 Fig. 2a is a schematic view of a window for a motorcycle;

24 Fig. 2b is a schematic view of a window for a four wheel
25 vehicle;

Fig. 3 is a schematic view showing a situation in which a motorcycle is a follow-up object;

Fig. 4 is a schematic view showing a situation in which a motorcycle moves left during a follow-up traveling control;

Fig. 5 is a schematic view showing a situation in which a motorcycle travels in parallel with a second preceding vehicle during a follow-up traveling control;

Fig. 6 is a schematic view showing a situation in which a motorcycle overtakes a second preceding vehicle during follow-up traveling control;

Fig. 7 is a flowchart showing a routine of a follow-up traveling control; and

Fig. 8 is a flowchart showing a routine of a follow-up traveling control according to a second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Fig. 1, reference numeral 1 denotes a vehicle (own vehicle) on which an intervehicle distance automatically adjusting system (Adaptive Cruise Control: ACC) 2 as an example of a vehicle drive assist system, is mounted. The ACC system 2 is constituted by a traveling control unit 3, a stereoscopic camera 4 and a vehicle surroundings monitoring apparatus 5. When the ACC system is set to a constant speed control mode, the vehicle travels at a speed established by a vehicle driver and when the system is set to a follow-up traveling control

1 mode, the vehicle travels at a speed targeting the speed of a
2 preceding vehicle with a constant intervehicle distance to the
3 preceding vehicle maintained.

4 The stereoscopic camera 4 constituting vehicle forward
5 information detecting means is composed of a pair (left and right)
6 of CCD cameras using a solid-state image component such as Charge
7 Coupled Device and the left and right cameras are transversely
8 mounted on a front ceiling of a passenger compartment at a specified
9 interval of distance, respectively. The respective cameras take
10 picture images of an outside object from different view points
11 and input the picture images to the vehicle surroundings monitoring
12 apparatus 5.

13 Further, the own vehicle 1 has a vehicle speed sensor
14 6 for detecting a vehicle speed and the detected vehicle speed
15 is inputted to the traveling control unit 3 and the vehicle
16 surroundings monitoring apparatus 5, respectively. Further, the
17 Own vehicle 1 has a steering wheel angle sensor 7 for detecting
18 a steering wheel rotation angle and a yaw rate sensor 8 for detecting
19 a yaw rate of the own vehicle 1. Signals indicative of steering
20 wheel rotation angles and yaw rates are inputted to the vehicle
21 surroundings monitoring apparatus 5.

22 Further, the own vehicle 1 has a collision warning lamp
23 12 lighting in case where there is a possibility that the own
24 vehicle 1 collides with frontal obstacles (for example, a preceding
25 vehicle, a parked vehicle and other solid objects existing in

1 a traveling region of the own vehicle) in an instrument panel
2 (not shown). The collision warning lamp 12 is lit by an output
3 signal from the traveling control unit 3.

4 The vehicle surroundings monitoring apparatus 5 inputs
5 respective signals indicative of images from the stereoscopic
6 camera 4, vehicle speeds, steering wheel rotation angles, yaw
7 rates and detects frontal information such as solid object data,
8 side wall data, lane marker data and the like based on the images
9 from the stereoscopic camera 4. On the basis of these frontal
10 information and the traveling conditions of the own vehicle 1,
11 a traveling path of the own vehicle 1 (hereinafter, referred to
12 as an own traveling path) is estimated. A traveling region is
13 established based on the own traveling path and the preceding
14 vehicle, the vehicle traveling ahead of the preceding vehicle
15 and the like are recognized according to the state of existence
16 of solid objects in the traveling region and those results are
17 outputted to the traveling control unit 3. The vehicle surroundings
18 monitoring apparatus 5 acts as solid object detecting means.

19 The estimation of the own traveling path described
20 above is performed as follows. In this embodiment, the coordinate
21 system of the three-dimensional real space is transferred to a
22 coordinate system fixed to the own vehicle 1. That is, the coordinate
23 system is composed of X coordinate extending in a widthwise
24 direction of the own vehicle 1, Y coordinate extending in a vertical
25 direction of the own vehicle 1, Z coordinate extending in a

1 lengthwise direction of the own vehicle 1 and an origin of the
2 coordinate placed on the road surface directly underneath the
3 central point of two CCD cameras. The positive sides of X, Y and
4 Z coordinates are established in a right direction, in an upward
5 direction and in a forward direction, respectively.

6 **Method A: Estimation of traveling path based on lane markers**

7 In case where both or either of left and right lane
8 markers data are obtained and the profile of the lane on which
9 the own vehicle 1 travels can be estimated from these lane markers
10 data, the traveling path of the own vehicle is formed in parallel
11 with the lane markers in consideration of the width of the own
12 vehicle 1 and the position of the own vehicle 1 in the present
13 lane.

14 **Method B: Estimation of traveling path based on side wall data**
15 **such as guardrails, curbs, and the like**

16 In case where both or either of left and right side
17 walls data are obtained and the profile of the lane on which the
18 own vehicle 1 travels can be estimated from these side walls data,
19 the traveling path of the own vehicle is formed in parallel with
20 the side walls in consideration of the width of the own vehicle
21 1 and the position of the own vehicle 1 in the present lane.

22 **Method C: Estimation of traveling path based on a trace of the**
23 **preceding vehicle**

24 The own traveling path is estimated based on the past
25 traveling trace extracted from the solid object data of the

1 preceding vehicle.

2 Method D: Estimation of path based on trace of the own vehicle

3 The own traveling path is estimated based on the
4 traveling conditions such as yaw rate γ , vehicle speed V and
5 steering wheel rotation angle θ_H of the own vehicle 1 according
6 to the following processes:

7 First, it is judged whether or not the yaw rate sensor
8 is effective. If it is effective, the present turning curvature
9 C_{ua} is calculated according to the following formula (1).

$$10 \quad C_{ua} = \gamma / V \quad (1)$$

11 On the other hand, if the yaw rate sensor is ineffective,
12 it is judged whether or not the vehicle is steered at a steering
13 angle δ more than a prescribed angle (for example 0.57 radian)
14 obtained from the steering wheel rotation angle θ_H . In case where
15 the vehicle is steered at a steering angle more than 0.57 radian,
16 the present turning curvature C_{ua} is calculated according to the
17 following formulas (2), (3) using the steering angle δ and the
18 vehicle speed V of the own vehicle 1:

$$19 \quad R_e = (1 + A \cdot V^2) \cdot (L / \delta) \quad (2)$$

$$20 \quad C_{ua} = 1 / R_e \quad (3)$$

21 where R_e is turning radius; A is stability factor of the vehicle;
22 and L is wheelbase of the vehicle.

23 Further, if the steering angle is smaller than 0.57
24 radian, the present turning curvature is set to 0 (in a
25 straightforward traveling condition).

1 Then, an average turning curvature is calculated from
2 total turning curvatures for the past specified time (for example,
3 0.3 seconds) including the present turning curvature C_{ua} thus
4 obtained and the own traveling path is estimated from the average
5 turning curvature.

6 Even in case where the yaw rate sensor 8 is effective
7 and the present turning curvature C_{ua} is calculated according
8 to the formula (1), if the steering angle δ is smaller than 0.57
9 radian, the present turning curvature C_{ua} may be corrected to
10 0 (straightforward traveling condition).

11 The traveling region of the own vehicle 1 is established
12 by adding a width 1.1 meters to the left and right sides of thus
13 estimated own traveling path, respectively.

14 Describing the processing of images from the
15 stereoscopic camera 4 in the vehicle surroundings monitoring
16 apparatus 5, with respect to a pair of stereoscopic images of
17 surroundings taken by the stereoscopic camera 4 in a forward
18 direction of the own vehicle 1, distance information over the
19 entire image is obtained from the deviation amount between two
20 corresponding positions according to the principle of
21 triangulation and a distance image representing three-dimensional
22 distance distribution is formed based on the distance information.
23 Then, lane marker data, side wall data such as guardrails, curbs
24 and side walls arranged along the road and solid object data such
25 as vehicles and the like, are extracted based on the distance

1 image by means of the known grouping process and the like by
2 referring to frames (windows) of the three-dimensional road
3 profile data, side wall data, solid object data and the like stored
4 beforehand.

5 These windows used for the extraction of the solid
6 object data have been preestablished like a dedicated window for
7 motor cycles as shown in Fig. 2a, and a dedicated window for
8 four-wheel vehicles as shown in Fig. 2b. The dedicated window
9 for motor cycles has a narrow width DB and the one for four-wheel
10 vehicles has a wide width DV. The width of the extracted solid
11 objects (width of window) is finally corrected to the width of
12 the solid object data subjected to the grouping process. In case
13 where objects existing at the same distance ahead are applied
14 to a certain window, for example, there is possibility that the
15 state of running in parallel is recognized as one large object
16 having a width DS, as shown in Fig. 5. Hence, in the present
17 embodiment, in case where the width of the window exceeds a
18 preestablished value, the preceding vehicle is discriminated from
19 the vehicle traveling ahead of the preceding vehicle based on
20 the direction of the passing preceding vehicle, the width of the
21 preceding vehicle and the width of the vehicle traveling ahead
22 of the preceding vehicle. These widths of the preceding vehicle
23 and the vehicle traveling ahead of the preceding vehicle are
24 memorized before it is judged that the width of the window exceeds
25 the preestablished value. In this case, either of the widths of

1 the preceding vehicle and the vehicle traveling ahead of the
2 preceding vehicle may be memorized.

3 A different number is assigned to thus extracted lane
4 marker data, side wall data and solid object data, respectively.

5 Further, the solid object data are classified into stationary
6 objects, a forward moving object moving in the same direction
7 as the own vehicle 1 and the like based on the relationship between
8 the relative displacement of the distance from the own vehicle
9 1 and the vehicle speed of the own vehicle 1 and are outputted.

10 If there is an outstanding forward moving object detected
11 successively for a specified time and the solid object is located
12 nearest to the own vehicle 1, the solid object is deemed to be
13 a preceding vehicle and registered as such. Further, a forward
14 moving object existing in front of the preceding vehicle in the
15 own traveling region of the own vehicle 1 is registered as a vehicle
16 traveling ahead of the preceding vehicle (hereinafter referred
17 to as a second preceding vehicle). The situation where the
18 preceding vehicle passes the second preceding vehicle is judged
19 from the state where the intervehicle distance between the
20 preceding vehicle and the second preceding vehicle is decreasing
21 or from the state where the widthwise movement of the preceding
22 vehicle is detected. The intervehicle distance between the
23 preceding vehicle and the second preceding vehicle is calculated
24 from a difference of the intervehicle distance between the own
25 vehicle and the preceding vehicle from the intervehicle distance

1 between the own vehicle and the second preceding vehicle.

2 The traveling control unit 3 acts as traveling control
3 means and is connected with a constant speed traveling switch
4 9, the vehicle surroundings monitoring apparatus 5, the vehicle
5 speed sensor 6 and the like. The traveling control unit 3 has
6 a function of a constant speed control in which the traveling
7 speed is maintained at a speed established by a driver and a function
8 of a follow-up traveling control in which the intervehicle distance
9 between the own vehicle 1 and a solid object like a preceding
10 vehicle is kept constant. The constant speed traveling switch
11 9 is disposed at the lateral side of the steering column and is
12 constituted by a plurality of switches connected with a constant
13 speed traveling selector lever.

14 The constant speed traveling switch 9 is constituted
15 by a speed setting switch for setting a target vehicle speed at
16 a constant speed traveling, a coast switch for changing the target
17 vehicle speed in a descending direction and a resume switch for
18 changing the target vehicle speed in an ascending direction.
19 Further, a main switch (not shown) for switching the traveling
20 control on or off is disposed in the vicinity of the constant
21 speed traveling selector lever.

22 When a driver turns the main switch on and sets a desired
23 vehicle speed by operating the constant speed traveling selector
24 lever, a signal indicative of the desired vehicle speed inputs
25 from the constant speed traveling switch 9 to the traveling control

1 unit 3 and a throttle valve 11 driven by a throttle actuator 10
2 makes a feed-back control so as to converge the vehicle speed
3 detected by the vehicle speed sensor 6 to the established vehicle
4 speed. As a result, the own vehicle 1 can travel at a constant
5 speed automatically.

6 Further, when the traveling control unit 3 makes a
7 constant traveling control, supposing a case where the vehicle
8 surroundings monitoring apparatus 5 recognizes a preceding
9 vehicle, which is traveling at a lower speed than the established
10 vehicle speed of the own vehicle 1, the preceding vehicle is
11 established as an object to be followed up and the traveling control
12 unit 3 automatically changes over to a follow-up traveling control
13 mode in which the own vehicle 1 travels with an established
14 intervehicle distance retained. As shown in the flowchart of Fig.
15 7, in case where the preceding vehicle established as the object
16 to be followed up passes the second preceding vehicle, an object
17 to be followed up is automatically shifted to that overtaken
18 vehicle.

19 When the constant speed traveling control mode
20 transfers to the follow-up traveling control mode, an appropriate
21 target value of an intervehicle distance between the own vehicle
22 1 and the preceding vehicle is established based on the
23 intervehicle distance between the own vehicle 1 and the preceding
24 vehicle, the vehicle speed of the own vehicle 1 detected by the
25 vehicle speed sensor 6 and the vehicle speed of the preceding

1 vehicle. Further, a drive signal is outputted to the throttle
2 actuator 10 so that the intervehicle distance agrees with the
3 target value. As a result, the opening angle of the throttle valve
4 11 is feedback-controlled and the own vehicle 1 follows up the
5 preceding vehicle with a constant intervehicle distance retained.

6 Further, in the traveling control unit 3, as hereinafter
7 will be described in more detail by a flowchart of Fig. 7,
8 particularly in case where the preceding vehicle as an object
9 of following-up is a motor cycle, when the motor cycle makes an
10 acceleration to pass the vehicle traveling ahead of the preceding
11 vehicle, the traveling control unit 3 is designed so as to inhibit
12 acceleration.

13 Further, the traveling control unit 3 is designed so
14 as to continue to establish the motorcycle as a follow-up object
15 until the motor cycle runs in parallel with the second preceding
16 vehicle. If the second preceding vehicle is established to be
17 a follow-up object before the preceding vehicle runs in parallel
18 with the second preceding vehicle, since the own vehicle 1 is
19 controlled according to the intervehicle distance between the
20 own vehicle 1 and the second preceding vehicle, there is fear
21 that the own vehicle 1 comes close to the motor cycle.

22 Further, particularly in case where the preceding
23 vehicle of a follow-up object is a motor cycle, and in case where
24 the motor cycle passes a parked vehicle, the traveling control
25 unit 3 has a function to light the collision warning lamp 12 for

1 a specified time (during which the own vehicle comes near the
2 parked vehicle). The specified time may be established to be
3 smaller as the speed of the own vehicle 1 is higher. Further,
4 the collision warning lamp 12 may be lit until the own vehicle
5 1 comes close to the parked vehicle within a specified distance.
6 Further, the specified distance may be established to be longer
7 as the vehicle speed is high.

8 Next, a follow-up traveling control routine in the
9 traveling control unit 3 will be described by referring to a
10 flowchart of Fig. 7. This program is executed every specified
11 time interval after the traveling control transfers to the
12 follow-up traveling control mode.

13 First, at S101, desired information and parameters,
14 specifically, information about the preceding vehicle and the
15 second preceding vehicle (including distance information and
16 vehicle speed information) is inputted from the vehicle
17 surroundings monitoring apparatus 5 and the vehicle speed of the
18 own vehicle 1 is inputted from the vehicle speed sensor 6.

19 Then, the program goes to S102 where the preceding
20 vehicle detected by the vehicle surroundings monitoring apparatus
21 5 is established a follow-up object. In case where the existence
22 of the preceding vehicle is not recognized in the vehicle
23 surroundings monitoring apparatus 5, it is judged that there is
24 no follow-up object.

25 Then, the program goes to S103 where it is judged whether

1 or not the present follow-up object is a motorcycle. In case where
2 the follow-up object is not a motorcycle, the program goes to
3 S104 where it is judged whether or not there is no follow-up object.
4 As a result of the judgment at S104, when it is judged that there
5 is no follow-up object, the program goes to S105 where the traveling
6 control transfers to a normal constant traveling control mode,
7 in which a throttle valve 11 driven by a throttle actuator 10
8 makes a feed-back control so as to converge the vehicle speed
9 detected by the vehicle speed sensor 6 to the established vehicle
10 speed, and the own vehicle 1 travels at a constant speed
11 automatically, leaving the routine.

12 Further, as a result of the judgment at S104, in case
13 where it is judged that there is a follow-up object, the program
14 goes to S106 where the normal follow-up control is performed.
15 That is, an appropriate target value of the intervehicle distance
16 between the own vehicle 1 and the preceding vehicle is established
17 based on the intervehicle distance between the own vehicle 1 and
18 the preceding vehicle, the vehicle speed of the own vehicle 1
19 detected by the vehicle speed sensor 6 and the vehicle speed of
20 the preceding vehicle. Further, a drive signal is outputted to
21 the throttle actuator 10 so that the intervehicle distance agrees
22 with the target value. As a result, the opening angle of the throttle
23 valve 11 is feedback-controlled and the own vehicle 1 follows
24 up the preceding vehicle with a constant intervehicle distance
25 retained. After that, the program leaves the routine.

1 On the other hand, in case where it is judged at S103
2 that the present follow-up object is a motorcycle (refer to Fig.
3 3), the program goes to S107 where it is judged whether or not
4 the motorcycle moves either left or right within the own traveling
5 region.

6 As a result of the judgment at S107, in case where the
7 motorcycle moves in neither directions, the program goes to S108
8 where the motorcycle is continued to be treated as a follow-up
9 object and the follow-up control targeting the motorcycle is
10 performed in the same manner as described in S106, leaving the
11 routine.

12 Further, as a result of the judgment at S107, in case
13 where the motorcycle moves either left or right, the program goes
14 to S109 where it is judged whether or not the second preceding
15 vehicle is detected.

16 In case where it is judged at S107 that the motorcycle
17 of the follow-up object moves either left or right and the second
18 preceding vehicle is detected at S109, it is judged that the
19 motorcycle is in the course of overtaking the second preceding
20 vehicle. Alternatively, in case where it is judged at S107 that
21 the motorcycle moves either left or right and the intervehicle
22 distance between the preceding vehicle and the second preceding
23 vehicle is decreasing, it may be judged that the motorcycle is
24 overtaking the second preceding vehicle. In case where the second
25 preceding vehicle is not detected at S109, the program goes to

1 S108 where the follow-up control aiming at the motorcycle is
2 performed in the same manner as described in S106, leaving the
3 routine.

4 Further, in case where the second preceding vehicle
5 is detected at S109 (refer to Fig. 4), the program goes to S110
6 where an acceleration control of the ACC system is placed in a
7 stand-by condition, that is, the acceleration of the own vehicle
8 is inhibited, even in case where the motorcycle makes
9 acceleration.

10 Then, the program goes to S111 where it is judged whether
11 or not the motorcycle travels in parallel with the second preceding
12 vehicle based on the distance to the preceding vehicle and the
13 distance to the second preceding vehicle. In case where the
14 motorcycle travels in parallel with the second preceding vehicle
15 (refer to Fig. 5), the program goes to S112. In case where the
16 motorcycle does not travel in parallel with the second preceding
17 vehicle, the program returns to S109 where the detection of the
18 second preceding vehicle is performed. If the second preceding
19 vehicle is detected, at S110 the follow-up traveling control
20 targeting the motorcycle is performed while the ACC acceleration
21 control is in a stand-by condition. That is, the motorcycle is
22 a follow-up object until the motorcycle runs in parallel with
23 the second preceding vehicle.

24 When it is judged at S111 that the motorcycle runs in
25 parallel with the second preceding vehicle and the program goes

1 to S112, it is judged whether or not the second preceding vehicle
2 is an obstacle or a parked vehicle. If it is judged that the second
3 preceding vehicle is an obstacle or a parked vehicle, the program
4 goes to S113 where a warning is outputted, that is, the collision
5 warning lamp 12 is lit for a specified time until the own vehicle
6 1 comes close to the parked vehicle and then goes to S108 where
7 the follow-up control targeting the motorcycle is continued,
8 leaving the routine.

9 On the other hand, as a result of the judgment at S112,
10 in case where it is judged that the second preceding vehicle is
11 neither an obstacle nor a parked vehicle, the program goes to
12 S114 where the second preceding vehicle is established as a new
13 follow-up object and at S115 the second preceding vehicle starts
14 to be followed up, leaving the routine. This situation is
15 illustrated in Fig. 6.

16 According to the first embodiment of the present
17 invention, when the preceding vehicle of the own vehicle 1 is
18 a motorcycle and the motorcycle is established as a follow-up
19 object, the widthwise movement of the motorcycle is detected,
20 further when the second preceding vehicle traveling ahead of the
21 motorcycle is detected, the own vehicle 1 is inhibited to
22 accelerate, in case where the motorcycle makes an acceleration.
23 Hence, even in case where the motorcycle attempts to overtake
24 the second preceding vehicle, the own vehicle 1 is inhibited to
25 accelerate and as a result the own vehicle 1 is prevented from

1 coming too close to the second preceding vehicle.

2 Further, since the motorcycle is established as a
3 follow-up object until the motorcycle travels in parallel with
4 the second preceding vehicle, the own vehicle 1 does not come
5 too close to the motorcycle.

6 Under such a condition as the motorcycle and the four
7 wheel vehicle run in parallel, there is possibility that these
8 objects are recognized as one large object having a width DS.
9 In the first embodiment, first the width of the preceding vehicle
10 and the width of the second preceding vehicle are memorized,
11 respectively. In case where an object having such a large width
12 DS is detected, which side of the second preceding vehicle the
13 preceding is overtaking on is judged from the direction of moving
14 of the preceding vehicle and the preceding vehicle can be
15 accurately recognized separately from the second preceding vehicle
16 based on the direction of moving of the preceding vehicle and
17 the width of respective vehicles.

18 Fig. 8 is a flowchart of a follow-up control program
19 according to a second embodiment. The feature of the second
20 embodiment is that, in case where the motorcycle travels in
21 parallel with the second preceding vehicle and the second preceding
22 vehicle is neither an obstacle nor a parked vehicle, a vehicle
23 traveling slower is established as a follow-up object. Other
24 functions except this feature are identical to those described
25 in the first embodiment.

1 That is, as shown in the flowchart of Fig. 8, as a result
2 of the judgment at S112, in case where it is judged that the second
3 preceding vehicle is neither an obstacle nor a parked vehicle,
4 the program goes to S201. At S201, if the speed of the second
5 preceding vehicle is larger than that of the motorcycle, the program
6 goes to S108 where the motorcycle is still be established as a
7 follow-up object, leaving the routine.

8 On the other hand, if the speed of the motorcycle is
9 larger than that of the second preceding vehicle, the program
10 goes to S114 where the follow-up object is transferred to the
11 second preceding vehicle and then goes to S115 where the second
12 preceding vehicle is established as a new follow-up object,
13 leaving the routine.

14 Thus, according to the second embodiment, since the
15 speed of the motorcycle is compared with that of the second preceding
16 vehicle traveling in parallel and the follow-up object can be
17 appropriately selected, more accurate and more practical control
18 is available.

19 In the respective embodiments of the present invention,
20 the motorcycle is exemplified as a preceding vehicle and the
21 follow-up control has been described about the case in which the
22 preceding vehicle (motorcycle) overtakes the second preceding
23 vehicle (four wheel vehicle). However, the four wheel vehicle
24 may be a preceding vehicle and the same follow-up control may
25 be applied to the case in which the preceding vehicle (four wheel

1 vehicle) overtakes the second preceding vehicle (four wheel
2 vehicle).

3 The entire contents of Japanese Patent Application No.
4 Tokugan 2003-056271 filed March 3, 2003, is incorporated herein
5 by reference.

6 While the present invention has been disclosed in terms
7 of the preferred embodiments in order to facilitate better
8 understanding of the invention, it should be appreciated that
9 the invention can be embodied in various ways without departing
10 from the principle of the invention. Therefore, the invention
11 should be understood to include all possible embodiments which
12 can be embodied without departing from the principle of the
13 invention set out in the appended claims.

14